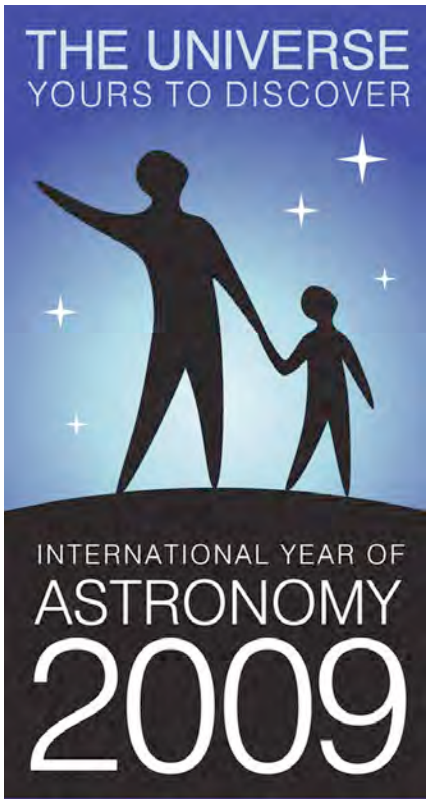
December 2009
IYA Discovery Guide



This Month's Theme:

Discovering New Worlds

Featured Activity:

What's the "Habitable Zone"?

Featured Observing Object:

Orion Nebula

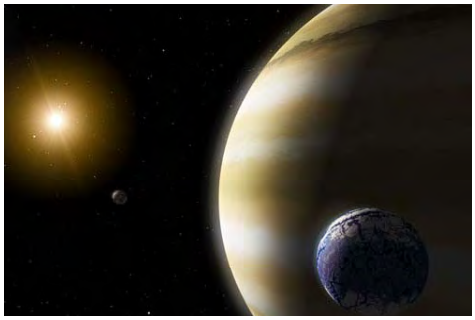
The International Year of Astronomy is a global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
Join us as we look up! http://astronomy2009.us

The Astronomical Society of the Pacific increases the understanding and appreciation of astronomy by engaging scientists, educators, enthusiasts and the public to advance science and science literacy.
http://www.astrosociety.org

December's Topic:
Discovering New Worlds

Watching the night sky as it appears to spin slowly overhead, it is no wonder that humans once thought they were the center of the universe. But when Galileo looked up through a telescope 400 years ago, our view of our place in the universe began to change dramatically. We discovered that the Earth is only one of eight planets orbiting the Sun. And that was only the beginning of the surprises.

The recent discovery of planets orbiting other stars, or exoplanets, has been changing the way we think of our Solar System and of planets in general. Scientists now estimate that there are probably billions of exoplanets in our Milky Way galaxy. They have discovered planetary systems that are very different from our own, including gas giant planets that orbit their star in a matter of days, not years like Jupiter or Saturn.



Artist's concept of an exoplanet from NASA/JPL

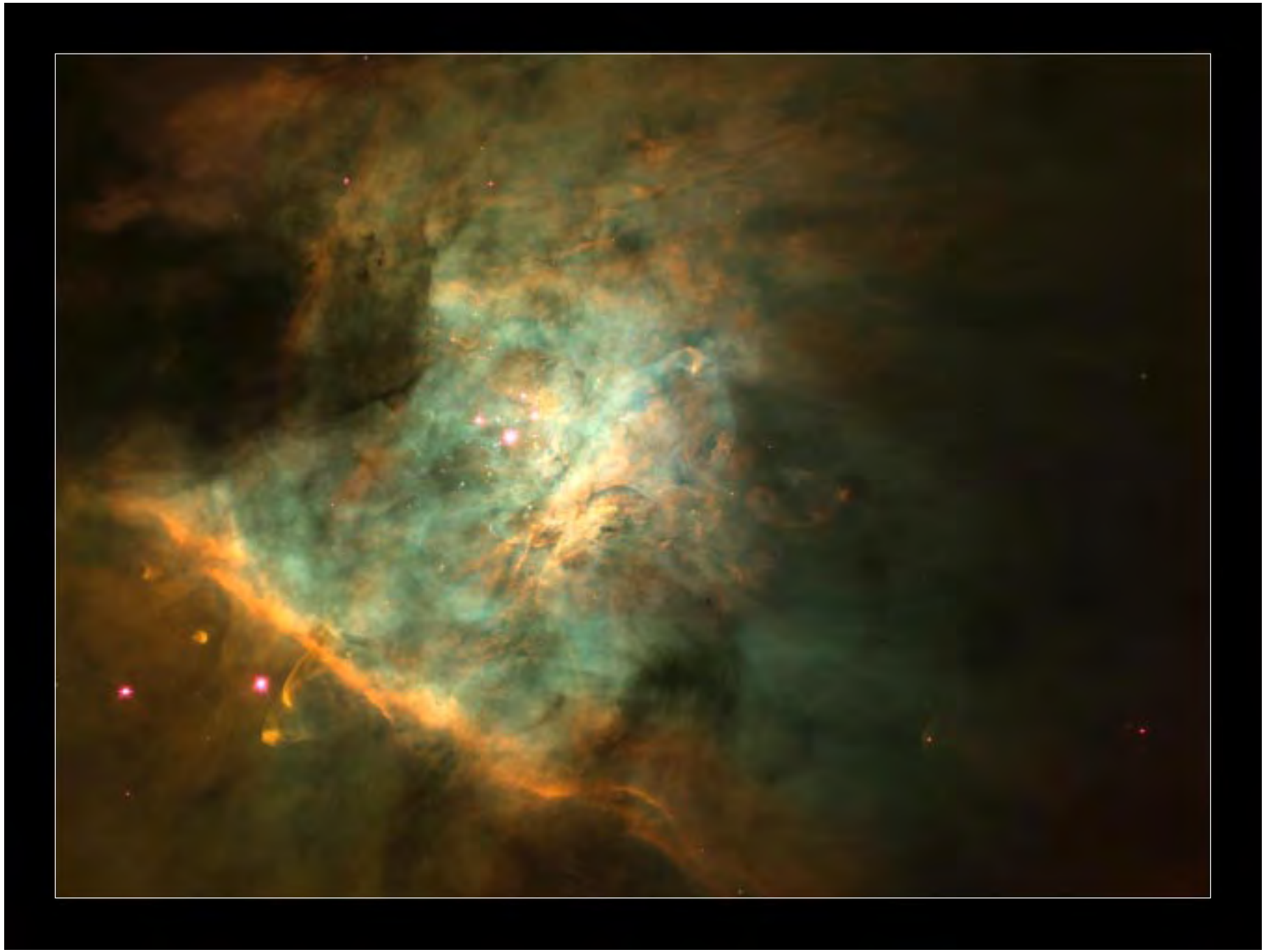
The discovery of other planetary systems has scientists wondering about the possibility of life on other planets. The field of astrobiology studies the possibility of life on other planets. Scientists look at some of the most extreme environments on Earth to find what conditions life on other planets might be able to tolerate. Use the activity included in this packet to find out where scientists plan to look for other planets that may harbor life.

The more we learn, the less significant and, at the same time, more extraordinary our home planet appears to be. Today we know our planet orbits a star in a vast galaxy full of billions of other stars – many with planets of their own orbiting them. Yet we have still not discovered life on any planet except our own, still do not know how common our type of planet might turn out to be, nor whether the life is rare or common in the universe.

NASA is studying planets around other stars with the PlanetQuest Exoplanet Exploration program. NASA scientists are specifically looking for terrestrial planets with the Kepler mission. Kepler will survey the Milky Way galaxy to look for these Earth-sized planets in or near the habitable zones of their stars, where liquid water and possibly life might exist. To see how researchers in astronomy and biology are working together, take a look at the NASA Astrobiology program. The James Webb Space Telescope will soon be able to peer into clouds of dust where stars are being born and watch as planets form in stellar nurseries.

Learn more about the Discovering New Worlds from NASA.
Find more activities featured during IYA 2009.
See what else is planned for the International Year of Astronomy.

Orion Nebula



Orion Nebula

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Orion Nebula

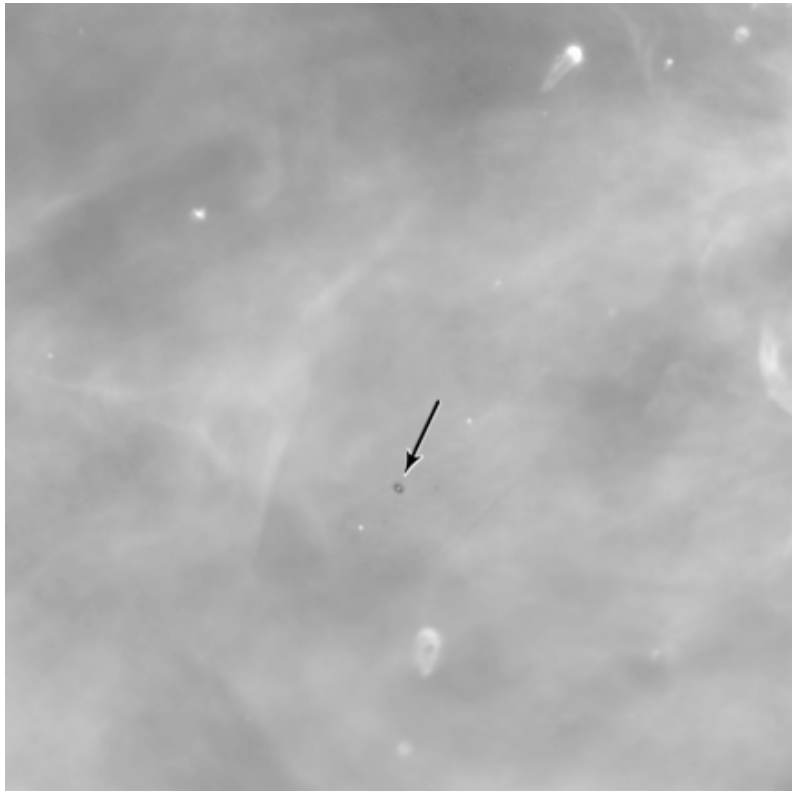
The Orion Nebula is a region filled with hot gas and dust, the raw materials for building new stars. It is located in the area of the sword of Orion the Hunter, a constellation named by ancient Greeks that dominates the northern hemisphere winter sky. The Nebula appears as a fuzzy, starlike area, which is visible without a telescope on clear, dark nights. The Nebula is nearby: it is 1,500 light-years away in our spiral arm of the Milky Way Galaxy.

Crucible of Creation

Four of the Nebula's hottest and most massive stars lie near the center of the image. Light from these stars illuminates the Nebula's "cavern" just as flashlights light up a cave. The cavern contains 700 other young stars at various stages of formation. Some of the infant stars send jets of hot gas into the Nebula at 100,000 miles per hour. These jets appear as thin curved loops, sometimes knotting at the end where they hit denser material. The brightest examples are near the reddish star in the image's lower left.

Planets Under Construction

The Orion Nebula also contains 153 glowing disks thought to be infant solar systems *(see detail image, right)*. Many of the Nebula's young stars are embedded in the middle of pancake-shaped disks of dust and gas. Astronomers think the disks, called protoplanetary disks or proplyds, may be an early stage of planet formation. Our solar system probably formed out of just such a disk 4.5 billion years ago.



About the Image

This spectacular panorama *(front)* is one of the largest pictures ever assembled using NASA's Hubble Space Telescope. The mosaic contains some 45 separate images taken in blue, green, and red light between January 1994 and March 1995. Astronomer C. Robert O'Dell of Rice University matched and combined the images to look as they would to someone living near the Nebula.

Definitions

Nebula: *A cloud of interstellar gas and dust, seen as either a luminous patch of light or a dark cloud against a bright background. The term was coined to describe objects that appeared fuzzy when viewed through early telescopes.*

Nuclear Fusion: *Two or more light nuclei join together to form a heavier nucleus, releasing energy in the process.*

Protoplanetary Disks/Proplyds: Disks thought to be made of 99% gas and 1% dust. They appear around young stars, and may evolve into planetary systems like our own.

Light-Year: *The distance light travels in a year (6×10^{12} or 5 trillion, 900 billion miles).*

Fast Facts

Age

The four bright central stars are less than a million years old. The Nebula is the same age or younger.

Location

In the constellation Orion the Hunter in the northern hemisphere

Distance from Earth

1,500 light years

Size

2.5 light years across, covering an area of sky about 5% of the area covered by the full Moon

Electronic Addresses

You can get images and other information about the Hubble Space Telescope on the World Wide Web.

Point your browser (Netscape Navigator, Microsoft Internet Explorer, and others), to URL `http://hubble.stsci.edu/` and follow links from there.

HqL-429 1/96 / STScI L-97-02

Image credit: NOAO

December 2009
Featured Observing Object

M42: Orion Nebula

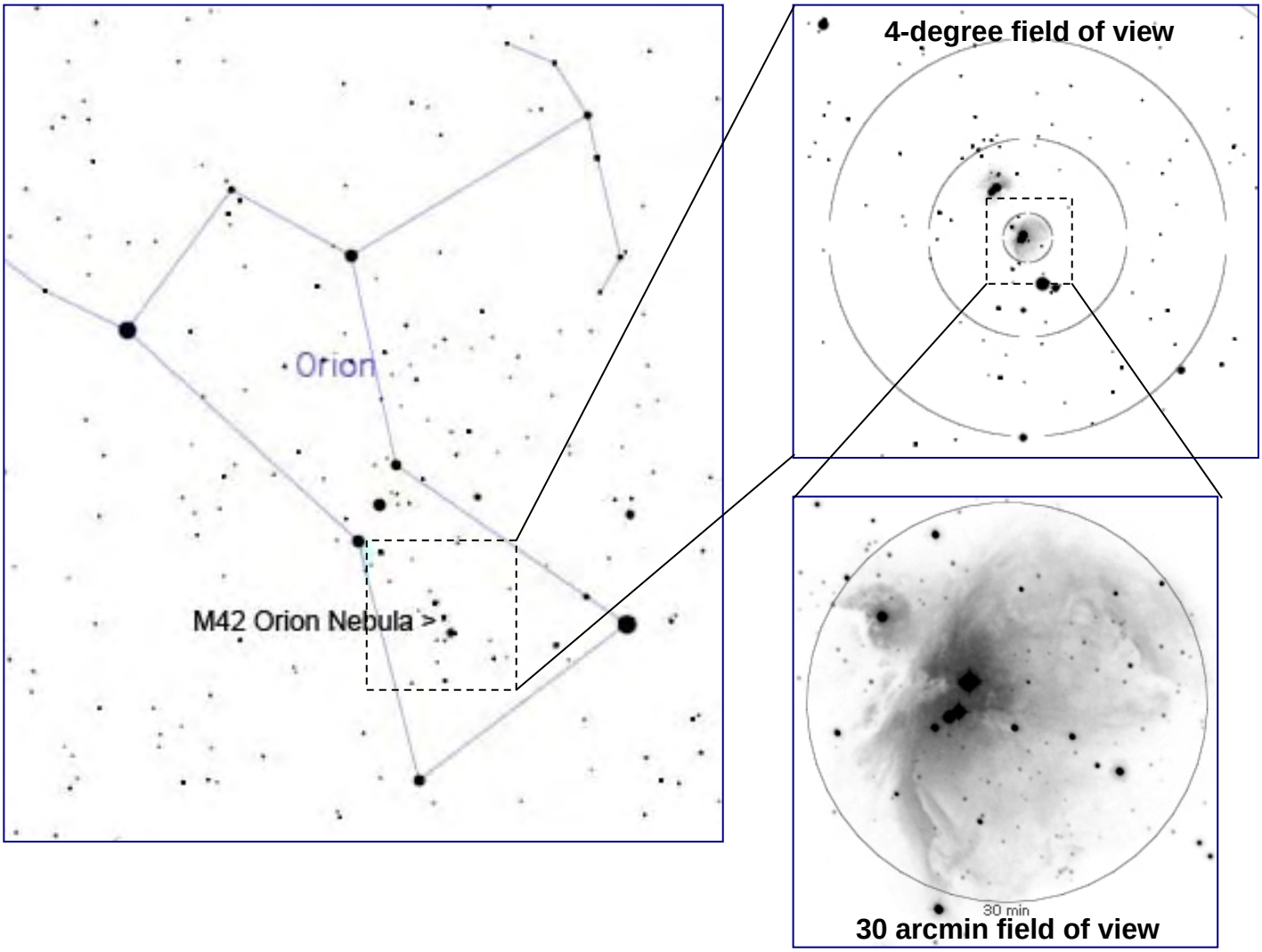
Finder Chart

For information about M42: http://seds.org/messier/M/m042.html

R.A. 5h 35.4m
Dec -05:27
Distance: 1,300 light years
Visual Magnitude: 4.0
Apparent Dimension: 85x60 arcminutes

To view: binoculars or telescope

In December 2009, in the late evening the Orion Nebula (M42) is above the southeast horizon in the constellation of Orion. This is the view from the Northern Hemisphere. It is toward the northeast from the Southern Hemisphere. M42 is near the tip of the "sword" hanging from Orion's belt.



What's the "Habitable Zone"?

Why is there life on Earth and not on Venus or Mars?
What about planets around other stars?

About the Activity

Model the habitable zone around stars and how an atmosphere influences the habitability of a planet.

Materials Needed

- 1 – Red Candle (representing a small, red star)
- 1 – sheet of yellow cellophane (for the campfire representing a sun-like star)
- 3 – sheets of blue cellophane (for the bonfire representing a hot, blue star)
- *(Optional)* Small bead or ball representing the Earth

Topics Covered

- How a planet's atmosphere and the distance from its sun affect conditions.
- What kind of planet has liquid water?

Participants

Use this activity with families, the general public, and school or youth groups ages 8 and up. It is best with a group of at least 10 people.

Location and Timing

This activity is great for classrooms, star parties, and other interactive settings. It can be held during the day or at night. It takes about 15 minutes to complete.

Included in This Activity

Detailed Activity Description
Background Information

This activity was developed from an idea in NASA's "Astro-Venture" guide: http://astroventure.arc.nasa.gov/

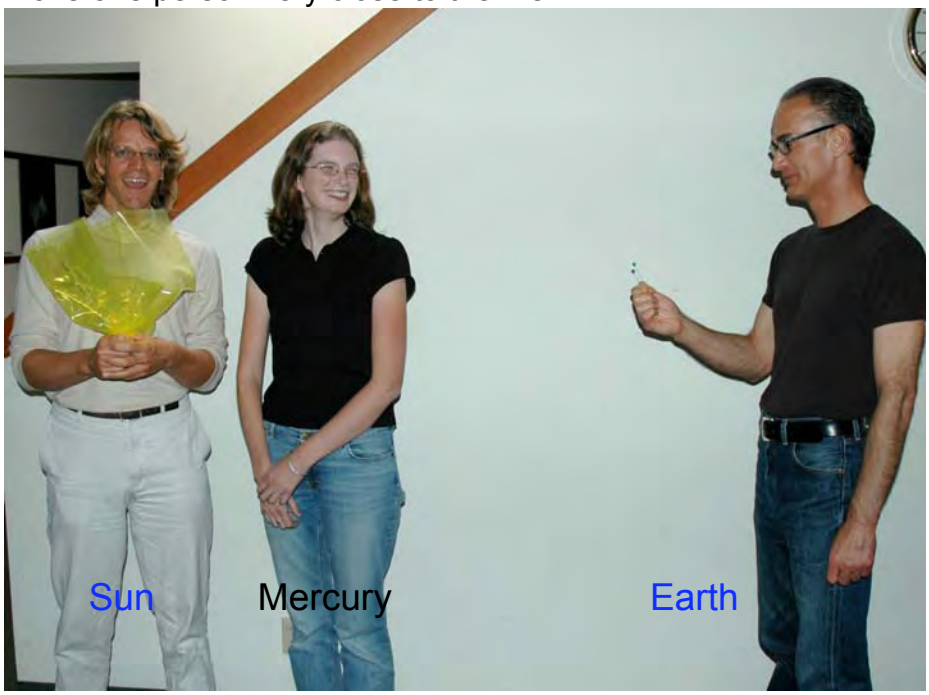
Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov
Astronomical Society of the Pacific www.astrosociety.org

Detailed Activity Description

What's the "Habitable Zone"? Why is there abundant life on Earth and not on Venus or Mars?

Leader's Role	Participants' Role (Anticipated)
To Say: Look up – what do you mostly see in the sky at night?	Stars!
Can we see any stars in the daytime?	Yes, one – our Sun
Does our star have planets orbiting it?	Yes.
Do you suppose some of the stars we see at night also have planets orbiting them?	Maybe.
Yes. Scientists have already found many that do, but only planets that are very large, close to the size of Jupiter and bigger.	Don't know.
Do you suppose some of those planets might be able to support life?	Maybe.
NASA's *Kepler Mission*, within about five to eight years, will determine if small Earth-size planets exist around other Sun-like stars. It is looking for planets in the habitable zone of stars.	
But what is a "habitable zone"? Why do you suppose there is so much life on Earth and no apparent life on Venus or Mars?	Variety of answers.
Earth is in the "habitable zone" of our star, the Sun. Let's see what it means.	

Leader's Role	Participants' Role (Anticipated)
PART I: Habitable Zone of a Sun-Like Star **This section addresses the topic of "habitable zone" and how atmosphere affects the habitability of a planet.** *To Do:*   Grab the sheet of yellow cellophane in the center and flare it into a bouquet shape. *To Say:* Pretend we are outside on a cold night and all we have is this campfire. *To do:* Give the campfire prop (one sheet of yellow cellophane) to one person. *To say:* Imagine this fire is as big as [his/her] upper body. *(Point to someone in the crowd)* Where would you have to stand to be comfortable? The campfire represents the Sun and you represent the position of Earth. Does Earth have liquid water? What about the people in the back – would you be comfortable? Would you be too warm?	Person adjusts their position. Yes. Lots. No. No! Too cold.

Leader's Role	Participants' Role (Anticipated)
To do: Move one person very close to the fire.  *To say:* I need you to take off your jacket. Would you be comfortable here?	No, I'd be too hot.
To say: *(Indicating person next to fire)* This person is like Mercury – too close to the Sun. Mercury has a daytime high temperature of 800° F (430° C). Can liquid water exist on its surface? *To do:* Pick another person and place him/her far from the campfire *To say:* I'm going to ask you to take off your jacket too. This person is like Mars – too far from the Sun and too cold. The temperature at the planet's surface varies widely during the course of a Martian day, from about -125° F (-87° C) just before dawn and warms up to about -4° F (-20° C) in the afternoon. Can it have liquid water? *(Indicating the person in the middle)* This person is like Earth – just right. Earth is in the habitable zone around our star, the Sun.	No – that's way too hot. Removes jacket. No– it would all be frozen.

Leader's Role	**Participants' Role (Anticipated)**
To say: The "habitable zone" around a star is where liquid water could exist on the planet's surface year-round. What's the most common substance in most living things?	Water?
Yes, Water! And not just any water, but liquid water. Most living things we know of require liquid water to live. So one thing that determines habitability is a planet being at the right distance from its star so the planet might have liquid water.	
To Say: Now let's look at something else that determines habitability: an atmosphere! Let's use a jacket to represent a planet's atmosphere. Why do you suppose I had Mars and Mercury take their jackets off? Mars and Mercury have little or no atmosphere. Wearing a jacket is like a planet having an atmosphere. Earth has just the right amount of atmosphere to insulate it and maintain a comfortable temperature.	No atmosphere?
The Moon is essentially the same distance form the Sun as Earth – but has no life and no liquid water - what's different? Right – no atmosphere – daytime temp on Moon:273° F (134° C) Nighttime temp on Moon: -274° F (-170° C)	No atmosphere!
But we have a planet missing. Which planet is between Mercury and the Earth? *(Select another person from the audience)* Would you stand here and be Venus? Venus has a very dense atmosphere. I'm going to have you keep your jacket on and imagine that I'm putting another other big down jacket on you too. Imagine I'm also wrapping a blanket around you. Would you be comfortable here?	Venus! OK. No – I'd get way too hot.
Right – Venus has too dense an atmosphere too close to the Sun. The temperature of Venus is always about 880° F (470° C). Can it have liquid water?	No.
So an atmosphere can make a big difference too in whether a planet might be habitable. Would it be easy for us to live on any of these planets, other than Earth?	No!

Leader's Role	Participants' Role (Anticipated)
PART II: Habitable Zone of Other Kinds of Stars **This section introduces the concept of different masses of stars along with the topic of "habitable zone".** *To Say:* But not all stars are like our Sun. Stars come in many different sizes. When a cloud of gas and dust collapses to form a group of stars, the stars are not all the same size, or mass. *To do:* Pick a person from the audience and give the candle to that person. Give the campfire prop (one sheet of yellow cellophane) to a second person. Pick 2 people to hold bonfire prop (2 sheets of blue cellophane). *To say:* These represent 3 different kinds of stars. *(Pointing to person with candle)* This candle represents a small cool red star. *(Pointing to person with campfire)* This campfire represents a yellow-white star like our Sun. Remember to think of the fire as being the size of his/her upper body. *(Pointing to people with bonfire)* Imagine this bonfire is as big as both of these people together. And what kind of star does this bonfire represent? Right, a hot massive bluish star.  	Holds props. A big, hot star.

Leader's Role	**Participants' Role (Anticipated)**
To Do: Line the "stars" up at least 5 feet (about 2 meters) apart from each other. You need 10 – 20 feet (or 3-6 meters) of clear space in front of them. *To Do:* Hand an Earth bead to one person from the audience. *To say:* *(To person with Earth bead)* Where would you place your planet in front of the candle so it would stay warm, but not too hot? *To Do:* Choose two other people. *To say:* Each of you stand at a distance from your fire where you can be comfortable. These represent stars with three different amounts of mass. You are each in the habitable zone of that star. Are each of the habitable zones the same distance from the star?	 Visitor holds bead close to candle. Visitors position themselves. No!
To say: *(Standing by the campfire)* As we mentioned, this campfire represents a star like our Sun. That's what we mean by "habitable zone around Sun-like stars". The stars like our Sun with planets in this vicinity *(indicating the position of the person standing in front of the star)* are what the *Kepler Mission* is hoping to detect. The mission will also collect information on other planets orbiting the stars and the variety of planetary systems in our neighborhood of the Galaxy.	
OPTIONAL Continuation of the activity: Have one person orbit the campfire in a highly elliptical orbit. *To Say:* If this fire represented another Sun-like star, and it had one planet with an orbit that brought it really close, then really far away (a highly elliptical orbit) – could you ever be comfortable on it? When it is close to the star, what would happen? How about when it is far away? Could that planet have liquid water on its surface year-round?	 You'd get too hot You'd get too cold. Not likely.

Background Information

More info on Mercury:
Virtually no atmosphere and very close to the Sun. Like being in the desert in a swimsuit. Daytime temp of Mercury is 660 F (250 C) and night side is about –300 F (–180 C).
(Mercury's "day" is about 58 Earth days long and its "year" is about 88 Earth days – it rotates very slowly)
More info on Venus:
Venus's "day" is about 243 Earth days long and its "year" is about 225 Earth days – it rotates very slowly.
Venus has a pressure at the surface about 90 times that of Earth - a pressure equivalent to a depth of 1 kilometer under the ocean – lie down and imagine the weight of one dictionary sitting on your chest. Now imagine 90 dictionaries.
More info on Mars:
Very little atmosphere – like wearing a t-shirt in the Arctic.
Mars pressure is like Earth at 20 miles up – 0.7% of the surface pressure on Earth.

Stellar Classification

Here is how we have classified the stars in this activity to take a more simplified approach to main sequence stars of various spectral types:
"Cool, red stars": Main Sequence stars of spectral type K, M, and cooler (lowest mass)
"Yellow/white stars": Main Sequence stars of spectral type G and F (mid-mass)
"Hot, bluish stars": Main Sequence stars of spectral type O, B, and A (higher mass)

All main sequence stars are classified as "dwarf" stars.
"White dwarf" is the hot core of a star that has lost its outer layers – a star that has "died".
"Red dwarf" is a cool, red main sequence star.

Giant stars (of various sizes) are stars that are “in retirement”, no longer burning primarily hydrogen. These are stars no longer on the main sequence. They still are given one of the above spectral types, but they are in a different “luminosity class”. Main sequence stars have a luminosity class of “V”. Here are the others:

Ia	Most luminous supergiants
Ib	Less luminous supergiants
II	Luminous giants
III	Normal giants
IV	Subgiants
V	Main sequence stars (dwarfs)

For more information on spectral types of stars:
http://antwrp.gsfc.nasa.gov/apod/ap040418.html (basic discussion - follow the links)
http://cas.sdss.org/dr4/en/proj/advanced/spectraltypes/ (tutorial)

The Night Sky Network's International Year of Astronomy (IYA) Discovery Guides are supported and sponsored by these NASA Forums and missions:

Space Telescope Science Institute's Origins Education Forum
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NASA JPL's PlanetQuest Exoplanet Exploration Program
Special Advisor: Michael Greene
NASA Lunar CRater Observation and Sensing Satellite (LCROSS)
NASA Education Forum on the Structure and Evolution of the Universe
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NASA Education and Public Outreach at Sonoma State University
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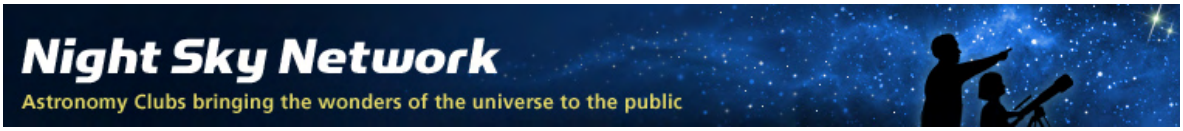

The Night Sky Network is a nationwide coalition of amateur astronomy clubs bringing the science, technology, and inspiration of NASA's missions to the general public.

We share our time and telescopes to provide you with unique astronomy experiences at science museums, observatories, classrooms, and under the real night sky.
http://nightsky.jpl.nasa.gov

The International Year of Astronomy (http://astronomy2009.us) aims to help citizens of the world rediscover their place in the Universe through the daytime and nighttime sky. Learn more about NASA's contributions to the International Year of Astronomy at http://astronomy2009.nasa.gov